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The Bryophyte Flora in the Urban Area of Aydın (Turkey)

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Abstract: In this study, the bryophyte diversity and urban bryophyte flora of the city of Aydın was investigated. Research area was divided into three zones and nearly 500 bryophyte specimens were collected in 13 representative stands. One hundred and twenty three moss species belong to 22 families and 78 genera, 22 liverwort species belong to 14 families and 19 genera and one hornwort species were found in the area. *Fossombronia echinata* and *Crossidium crassinerve* which were recently recorded from Turkey were collected from the area as a second distributional locality. *Tortula muralis*, *Didymodon vinealis*, *Grimmia pulvinata*, *Bryum argenteum* and *Orthotrichum diaphanum* are the most common species found in the city center where high pollution exists. The protected areas in the city centre such as gardens, cemeteries, school yards etc. are necessary in order to protect of bryophytes. These areas are important to provide various habitats to small organism like bryophytes.

Key words: Bryophyte, urban flora, pollution, Aydın, West Anatolia, Turkey

INTRODUCTION

Studies on the bryophyte flora of Turkey were carried out firstly in the 18th century by Müller (1829), Tchihatcheff (1860), Juratzka and Milde (1870), Wettstein (1889), Barbey (1890) and Schiffner (1896, 1897). Especially from late 20th century up to date, many studies were published. Among these, some floral studies were carried out in the city centre (Yayinta and Tonguç, 1996; Çetin and Uyar, 1997; Özdemir and Çetin, 1999; Özdemir, 2001; Ören *et al.*, 2007), but none of these discussed pollution and sensitive species. Besides, although a lot of studies covering the surroundings of Aydın and West Anatolian region have been published, the only available data for the area is reported by Kürschner *et al.* (2007).

Ecologically, bryophytes play a major role in maintaining an ecosystem's humidity level by their ability to absorb and retain water. Environmentally, they are often used as indicators of the habitat condition. Any change in water, soil and/or air quality, due to pollution or other factors, will have an impact on bryophyte growth (Söderström, 1988; Crites and Dale, 1998; Rambo and Muir, 1998; Jansová and Soldán, 2006).

The aim of this study was to explore the bryophyte flora in the urban area of Aydın. We hope that this study will serve as a valuable contribution to the knowledge of the bryoflora of Turkey and gives a base for future biodiversity and nature conservation surveys.

MATERIALS AND METHODS

The city of Aydın is located between 37° 59' N latitude, 27° 45' E longitude and 37° 43' N latitude, 28° 02' E longitude. It is divided by the İzmir-Aydın-Denizli Highway and surrounded by Aydın Mountains to the North, Büyük Menderes River to the South, Umurlu Town to the East and İncirliova Town to the West (Fig. 1). The average elevation above sea level is between 50 and 200 m.

Aydın is under the influence of Mediterranean climate. Mean annual air temperature is 17.1°C. Mean temperature in January is 4.1°C, while in July it is 34.8°C. Mean annual relative humidity is 62.08%. Mean annual precipitation is 672.7 mm and 70% is taken in the winter period (Fig. 2). Dominant wind direction is Westward (Aydın Province Environment Situation Report, 2006).

This study supported as a student project (Aydın İl Merkezi Karayosunu Florasi/The Moss Flora of Aydın city centre) by TÜBİTAK. It was started at 03.09.2007 and finished 03.09.2008. Bryophyte collection were made in this period. Research area was divided into three zones based on: (1) urbanizations and traffic density, (2) protected areas in city centre like gardens, cemeteries and school yards, (3) villages of Aydın city centre and at least tree localities were chosen from each area. Nearly 500 bryophyte specimens were collected in different seasons during the project time and identified the relevant floras

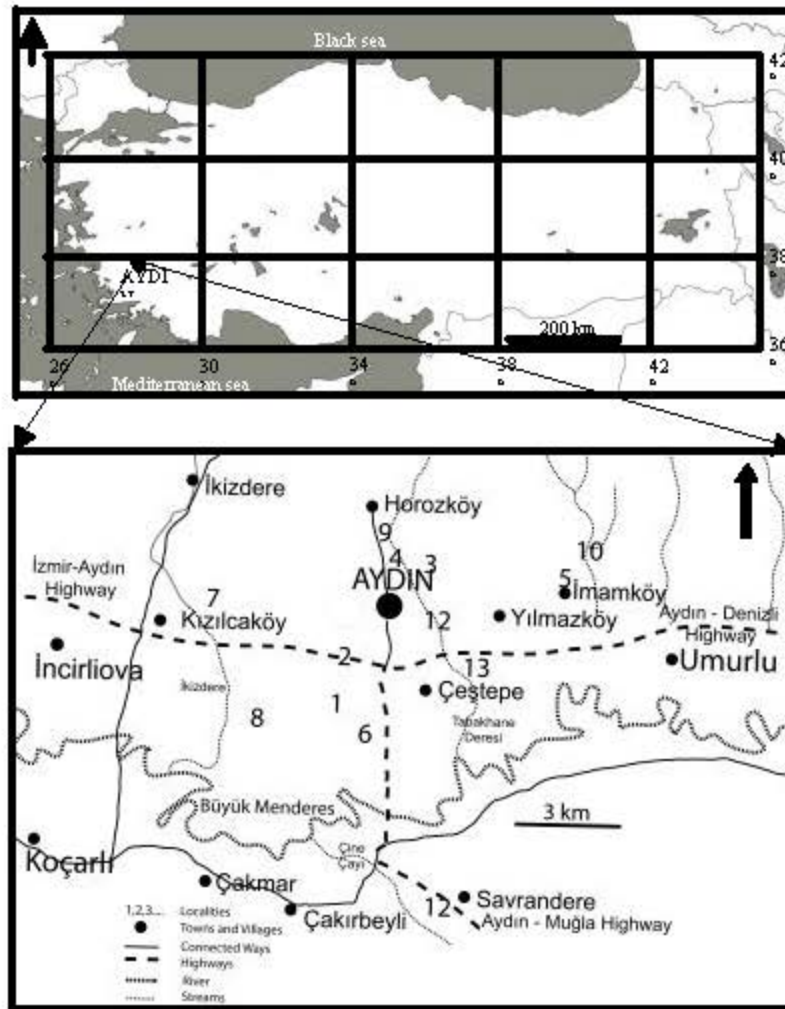


Fig. 1: The research area and sample places in the research area

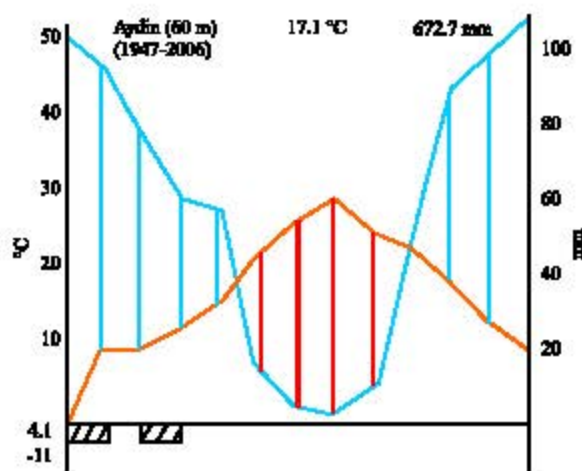


Fig. 2: Climate diagram of Aydın

and monographs (Zander, 1978; Crum and Anderson, 1981; Arnell, 1981; Nyholm, 1981, 1986; Frahm and Frey, 1987; Cano *et al.*, 1993; Zander, 1993; Greven, 1995; Paton, 1997; Hofmann, 1998; Muñoz, 1999; Pedrotti, 2001; Heyn and Herrstadt, 2004; Smith, 2004; Cano *et al.*, 2005; Jimenez *et al.*, 2005; Kürschner and Erdağ, 2005).

Moss taxa are listed adopting the taxonomy and nomenclature of the checklist of Hill *et al.* (2006), which in respects of the higher taxonomical ranks is based on the system Goffinet and Buck (2004). The treatment of hornworts and liverworts genera follows Grolle (1983). The recorded specific and subspecific taxa are listed alphabetically. For each taxon, only one collector number was given to avoid repetition in the floristic list but the same plants collected from different localities were indicated (loc. 1, 2, 3.). All specimens were deposited in Aydın (Herbarium of Adnan Menderes University,

Aydin, Turkey) and some duplicates were deposited in Hungarian Natural History Museum.

Abbreviations used in the text and appendix by collector and identifying author are EMA (Emre Ağcagil), MKIR. (Mesut Kirmaci), ERD. (Adnan Erdağ), Kursc. (Harald Kurschner), BEA (Beata Papp). Collection localities are presented in the following list with their coordinates and altitudes.

List of collection localities:

- Efeler Neighborhood/Around Yörük Ali Primary School, city centre/Aydin. N37° 50' 24,4'' E027° 49' 36,6'' Alt. 60 m, a) 03.11.2007 b) 10.03.2008
- Efeler Neighborhood/İzmir-Aydin Highway, city centre/Aydin. N37° 50' 34,2'' E027° 49' 41,5'' Alt. 60 m, 03.11.2007
- Around Adnan Menderes University (campus area) Kepez/Aydin. N37° 51' 43'' E027° 51' 34'' Alt. 180 m, a) 21.11.2007 b) 26.12.2007 c) 06.02.2008 d) 13.03.2008 e) 17.03.2008 f) 31.03.2008
- Kalfaköy/Aydin. N37° 52' 14,8'' E027° 51' 0,6'' Alt. 140 m, 15.12.2007
- İmamköy/Aydin. N37° 52' 5,9'' E027° 54' 27,9'' Alt. 150 m, a) 30.12.2007 b) 24.02.2008 c) 02.03.2008
- Tellidede Neighborhood (Tellidede Cemeteries), city centre/Aydin. N37° 49' 47,3'' E027° 50' 13,1'' Alt. 60 m, 10.03.2008
- Kizilcaköy/Aydin. N37° 52' 19,8'' E027° 46' 19,4'' Alt. 120 m, 14.03.2008
- Işikli Village (Işikli Cemeteries)/Aydin. N37° 50' 05'' E027° 48' 19'' Alt. 50 m, 07.04.2008
- Zeytinköy/Aydin. N37° 54' 03,8'' E027° 51' 13,7'' Alt. 270 m, 12.04.2008
- Between İmamköy and Paşayaylası (3 km to Paşayaylası),/Aydin. N37° 51' 59,6'' E027° 53' 49,1'' Alt. 170 m, a) 24.05.2008 b) 30.05.2008
- Zafer Neighborhood, city centre/Aydin. N37° 50' 59,3'' E027° 50' 47,4'' Alt. 75 m, 04.07.2008
- Savrandere Village/Aydin. N37° 44' 25,2'' E027° 52' 43,1'' Alt. 90 m, 15.03.2008
- Orta Mahalle/İzmir-Aydin Highway, city centre/Aydin. N37° 51' 41,2'' E027° 52' 30,5'' Alt. 60 m, 03.03.2008

RESULTS

The results indicated that 123 moss species belong to 22 families and 78 genera, 22 liverwort species belong to 14 families and 19 genera and one hornwort species were found in the area.

List of the species:

Anthocerotophyta

Anthocerotaceae

Phaeoceros laevis (L.) Proskauer

Loc: 5, on soil, EMA 99b, det. 30.02.2008 MKIR and EMA

Hepaticophyta

Sphaerocarpaceae

Southbya tophacea (Spruce) Spruce

Loc: 3,5, on soil, EMA 224, det. 14.05.2008 MKIR and EMA

Sphaerocarpos michelii Bellardi

Loc: 3, on soil, EMA 172, det. 19.03.2008 MKIR and EMA

Sphaerocarpos texanus Austin

Loc: 3,5,6, on soil, EMA 64, det. 30.05.2008, MKIR and EMA

Targioniaceae

Targionia hypophylla L.

Loc: 3, on soil, EMA 173b, det. 04.06.2008 MKIR and EMA

Aytoniaceae

Mannia androgyna (L.) A. Evans.

Loc: 3, on soil, EMA 45b, det. 27.12.2007 MKIR and EMA

Plagiochasma rupestre (J.R.Forst. and G.Forst.)

Loc: 3, on soil, EMA 51b, det. 03.01.2008 MKIR and EMA

Reboulia hemisphaerica (L.) Raddi

Loc: 3,4,5, on soil, EMA 21, det. 21.11.2007 MKIR and EMA

Lunulariaceae

Lunularia cruciata (L.) Dumort. ex Lindb.

Loc: 3, 5, 9, on soil, EMA 26, det. 21.11.2007 MKIR and EMA

Corsiniaceae

Corsinia coriandrina (Spreng.) Lindb.

Loc: 3, 4, on soil, EMA 24, det. 21.11.2007 MKIR and EMA

Oxymitracae

Oxymitra incrassata (Brotero) Sérgio and Sim-Sim

Loc: 12, on soil, Alt. 90 m, det. 15.03.2006 ERD and KURSC.

Ricciaceae

Riccia crozalsii Lev.

Loc: 12, on soil, Alt. 90 m, det. 15.03.2006 ERD and KURSC.

Riccia crystallina L.

Loc: 12, on soil, Alt. 90 m, det. 15.03.2006 ERD and KURSC.

Riccia gougetiana Durieu and Mont.

Loc: 12, on soil, Alt. 90 m, det. 15.03.2006 ERD and KURSC.

Riccia nigrella DC.

Loc: 3, on soil, det. EMA 49, 27.12.2007 MKIR and EMA
Riccia papillosa Moris
 Loc: 12, on soil, Alt. 90 m, det. 15.03.2006 ERD and KURSC.
Riccia sorocarpa Bisch.
 Loc: 2-3-4-5, on soil, EMA 16, det. 06.11.2007 MKIR and EMA
 Pelliaceae
Pellia endiviifolia (Dicks.) Dumort.
 Loc: 12, on soil, ERD 2558, det. 21.03.1999 ERD and KURSC.
 Codoniaceae
Fossombronia echinata Macvicar
 Loc: 5,6, on soil, EMA 97, det. 04.06.2008 MKIR and EMA
Fossombronia husnotii Corb.
 Loc: 3,12, on soil, EMA 46, det. 19.03.2008 MKIR and EMA
Petalophyllum ralfsii (Wils.) Nees and Gottsche
 Loc: 5, on soil, EMA 105, det. 19.03.2008 MKIR and EMA
 Aneuraceae
Aneura pinguis (L.) Dumort.
 Loc: 3, on soil, ERD 2257, det. 21.03.1999 MKIR and EMA
 Jungermanniaceae
Jungermannia sp. Schwäger.
 Loc: 5, on soil, EMA 60, det. 02.06.2008 MKIR and EMA

Bryophyta

Polytrichaceae
Polytrichum juniperunum Hedw.
 Loc: 10, on soil, EMA 290, det. 28.07.2008 MKIR and EMA
FUNARIACEAE
Enthostodon convexus (Spruce) Brugués
 Loc: 3, on soil, EMA 228a, det. 05.05.2008 MKIR and EMA
Enthostodon fascicularis (Hedw.) Müll.Hal.
 Loc: 3, on soil, EMA 88b, det. 23.02.2008 MKIR and EMA
Enthostodon mourettii (Corb.) Jelenc
 Loc: 5, on soil, EMA 138, det. 04.08.2008 MKIR and EMA
Enthostodon muhlenbergii (Turner) Fife
 Loc: 3, on soil, EMA 228a, det. 05.05.2008 MKIR and EMA
Enthostodon pulchellus (H. Philib.) Brugués
 Loc: 3,6,7, on soil, EMA 174, det. 02.08.2008 MKIR and EMA
Funaria hygrometrica Hedw.
 Loc: 1,2,3,8,11,13, on soil, EMA 3, det. 11.01.2008 MKIR and EMA
 Grimmiaceae
Grimmia dissimulata E. Maier
 Loc: 9, epilithic, EMA 268, det. 04.06.2008 MKIR and EMA
Grimmia funalis (Schwäger.) Bruch and Schimp.
 Loc: 7, epilithic, EMA 192a, det. 05.05.2008 MKIR and EMA
Grimmia laevigata (Brid.) Brid.

Loc: 7, epilithic, EMA 192b, det. 05.05.2008 MKIR and EMA
Grimmia lisae De Not.
 Loc: 5,9,10, epilithic, EMA 269, det. 04.06.2008 MKIR and EMA
Grimmia ovalis (Hedw.) Lindb.
 Loc: 7, epilithic, EMA 191a, det. 25.04.2008 MKIR and EMA
Grimmia pulvinata (Hedw.) Sm.
 Loc: 3,5,6,7,9,10,11, on soil, soil covered rock, EMA 279, det. 30.07.2008 MKIR and EMA
Grimmia trichophylla Grev.
 Loc: 3, epilithic, EMA 219, det. 21.05.2008 MKIR and EMA
Schistidium rivulare (Brid.) Podp.
 Loc: 9, epilithic, EMA 247, det. 06.08.2008 MKIR and EMA
 Fissidentaceae
Fissidens bryoides Hedw.
 Loc: 3,5,7,10, on soil, EMA 178, det. 21.05.2008 MKIR and EMA
Fissidens viridulus (Sw. ex anon.) Wahlenb.
 Loc: 3,7, on soil, EMA 31, det. 05.02.2008 MKIR and EMA
 Ditrichaceae
Ceratodon purpureus (Hedw.) Brid.
 Loc: 4, on soil, ERD 2843b, det. 10.11.2001 ERD
Cheilothela chloropus (Brid.) Broth.
 Loc: 5,6, on soil, EMA 69, det. 02.06.2008 MKIR and EMA
Pleuridium acuminatum Lindb.
 Loc: 3, on soil, EMA 220, det. 04.08.2008 MKIR and EMA
 Dicranaceae
Dicranella heteromalla (Hedw.) Schimp.
 Loc: 10, epilithic, EMA 293, det. 28.07.2008 MKIR and EMA
Dicranella howei Renauld and Cardot
 Loc: 3, on soil, EMA 22b, det. 05.02.2008 MKIR and EMA
Dicranella varia (Hedw.) Schimp.
 Loc: 3, 5, on soil, EMA 83, det. 30.05.2008 MKIR and EMA
 Pottiaceae
Timmiella barbuloidea (Brid.) Mönk.
 Loc: 5, 6, 9, 11, on soil, epiphytic, EMA 242, det. 06.07.2008 MKIR and EMA
Eucladium verticillatum (With.) Bruch and Schimp.
 Loc: 6, 10, epilithic, EMA 161, det. 10.03.2008 MKIR and EMA
Gymnostomum aeruginosum Sm.
 Loc: 10, epilithic, EMA 299, det. 30.07.2008 MKIR and EMA
Gymnostomum calcareum Nees and Hornsch.
 Loc: 3, 7, epilithic, EMA 183, det. 24.04.2008 MKIR and EMA
Gymnostomum viridulum Brid.
 Loc: 10, on soil, EMA 295, det. 28.07.2008 MKIR and EMA
Pleurochaete squarrosa (Brid.) Lindb.

- Loc: 3, 5, 6, on soil, EMA 153, det. 19.03.2008 MKIR and EMA
Tortella tortuosa (Hedw.) Limpr.
Loc: 7, on soil, soil covered rock, epilithic, EMA 193b, det. 24.03.2008 MKIR and EMA
Trichostomum brachydontium Bruch
Loc: 1, on soil, EMA 2, det. 27.12.2007 MKIR and EMA
Trichostomum crispulum Bruch
Loc: 3, 5, 7, 9, 10, on soil, soil covered rock, epilithic, EMA 294, det. 28.07.2008 MKIR and EMA
Acaulon muticum (Hedw.) Müll.Hal.
Loc: 5, on soil, EMA 127, det. 02.07.2008 MKIR and EMA
Aloina aloides (Koch ex Schultz) Kindb.
Loc: 5, 7, 9, on soil, epilithic, EMA 186, det. 29.05.2008 MKIR and EMA
Aloina ambigua (Bruch and Schimp.) Limpr.
Loc: 5, on soil, EMA 132, det. 02.07.2008 MKIR and EMA
Barbula convoluta var. *convoluta* Hedw.
Loc: 5, 10, on soil, EMA 298, det. 30.07.2008 MKIR and EMA
Barbula convoluta var. *sardoa* Schimp.
Loc: 11, on soil, EMA 314, det. 05.07.2008 MKIR and EMA
Barbula unguiculata Hedw.
Loc: 1, 3, 5, 6, 9, on soil, EMA 85, det. 06.02.2008 MKIR and EMA
Crossidium crassinerve (De Not.) Jur.
Loc: 7, soil covered rock, Alt. 120 m, 01.08.2008 (confirm BEA and MKIR 17.12.2008), EMA 182
Crossidium squamiferum (Viv.) Jur.
Loc: 4, epilithic, EMA 42, det. 18.12.2007 MKIR and EMA
Didymodon acutus (Brid.) K. Saito
Loc: 3, 5, 9, on soil, epiphytic, EMA 272, det. 04.06.2008 MKIR and EMA
Didymodon australasiae (Hook. and Grev.) R.H.Zander
Loc: 7, soil covered rock, EMA 190, det. 04.08.2008 MKIR and EMA
Didymodon fallax (Hedw.) R.H.Zander
Loc: 9, on soil, EMA 262, det. 07.08.2008 MKIR and EMA
Didymodon ferrugineus (Schimp. ex Besch.) M.O.Hill
Loc: 9, epilithic, EMA 252, det. 06.08.2008 MKIR and EMA
Didymodon insulanus (De Not.) M.O.Hill
Loc: 4, 5, soil covered rock, epilithic, EMA 37, det. 06.08.2008 MKIR and EMA
Didymodon luridus Hornsch.
Loc: 5, 6, 8, 9, 11, soil covered rock, epilithic, EMA 276, det. 05.08.2008 MKIR and EMA
Didymodon rigidulus Hedw.
Loc: 4, 5, 6, 7, 9, 11, on soil, epilithic, EMA 151, det. 19.03.2008 MKIR and EMA
Didymodon sinuosus (Mitt.) Delogne
Loc: 10, on soil, EMA 280, det. 27.07.2008 MKIR and EMA
Didymodon spadiceus (Mitt.) Limpr.
Loc: 5, on soil, near stream, EMA 56, det. 05.08.2008 MKIR and EMA
Didymodon tophaceus (Brid.) Lisa
Loc: 9, 10, on soil, epilithic, EMA 285, det. 27.08.2008 MKIR and EMA
Didymodon umbrosus (Müll.Hal.) R.H.Zander
Loc: 7, on soil, EMA 185, det. 04.04.2008 MKIR and EMA
Didymodon vinealis (Brid.) R. H. Zander
Loc: 5, 7, 8, 11, epilithic, EMA 238, det. 07.08.2008 MKIR and EMA
Microbryum davallianum (Sm.) R. H. Zander
Loc: 3, 9, on soil, EMA 86, det. 22.02.2008 MKIR and EMA
Microbryum floerkeanum (F. Weber and D. Mohr) Schimp.
Loc: 3, on soil, EMA 44, det. 05.02.2008 MKIR and EMA
Microbryum rectum (With.) R.H.Zander
Loc: 6, on soil, EMA 149, det. 04.06.2008 MKIR and EMA
Microbryum starckeanum (Hedw.) R. H. Zander
Loc: 5, on soil, EMA 51, det. 03.01.2008 MKIR and EMA
Phascum cuspidatum Schreb. ex Hedw. var. *cuspidatum* Nees and Hornsch.
Loc: 7, on soil, EMA 179, det. 22.05.2008 MKIR and EMA
Phascum cuspidatum Schreb. ex Hedw. var. *piliferum* (Hedw.) Hook. and Taylor
Loc: 5, on soil, epilithic, EMA 73, det. 30.05.2008 MKIR and EMA
Phascum cuspidatum var. *schreberianum* (Dicks.) Brid.
Loc: 3, on soil, EMA 211, det. 04.08.2008 MKIR and EMA
Phascum floerkeanum (F. Weber and D. Mohr) Schimp.
Loc: 3, on soil, EMA 91 b, det. 23.02.2008 MKIR and EMA
Pseudocrossidium hornschurchianum (Schultz) R. H. Zander
Loc: 2, 3, 8, on soil, EMA 231, det. 07.08.2008 MKIR and EMA
Pseudocrossidium revolutum (Brid.) R. H. Zander
Loc: 2, 3, 5, 7, on soil, epilithic, EMA 8, det. 17.12.2007 MKIR and EMA
Syntrichia montana Ness
Loc: 3, on soil, EMA 206, det. 21.04.2008 MKIR and EMA
Syntrichia laevipila Brid.
Loc: 6, 11, epilithic, epiphytic, EMA 318, det. 07.08.2008 MKIR and EMA
Syntrichia princeps (De Not.) Mitt.
Loc: 9, epilithic, EMA 263, det. 07.08.2008 MKIR and EMA
Syntrichia ruralis var. *ruralis* (Hedw.) F. Weber and D. Mohr
Loc: 4, on soil, epilithic, epiphytic, EMA 43b, det. 18.12.2007 MKIR and EMA
Syntrichia ruralis var. *ruraliformis* (Besch.) Delogne
Loc: 4, epiphytic, EMA 43b, det. 18.12.2007 MKIR and EMA

Tortula canescens Mont.

Loc: 5, epilithic, EMA 74, det. 29.05.2008 MKIR and EMA

Tortula cuneifolia (Dicks.) Turner

Loc: 3,7, on soil, epilithic, EMA 181, det. 24.04.2008 MKIR and EMA

Tortula lanceolata R. H. Zander

Loc: 7, on soil, EMA 185, det. 05.04.2008 MKIR and EMA

Tortula modica R.H.Zander

Loc: 5 on soil, EMA 132, det. 02.08.2008 MKIR and EMA

Tortula muralis Hedw.

Loc: 1, 2, 3, 4, 6, 7,8,10,11,13, soil covered rock, epilithic, EMA 4, det. 17.12.2008 MKIR and EMA

Tortula subulata Hedw.

Loc: 5,9, epilithic, EMA 248, det. 06.08.2008 MKIR and EMA

Tortula truncata (Hedw.) Mitt.

Loc: 3, epilithic, EMA 212, det. 23.05.2008 MKIR and EMA

Tortula vahliana (Schultz) Mont.

Loc: 7, soil covered rock, EMA 189, det. 04.08.2008 MKIR and EMA

Tortula wilsonii (Hook.) R.H.Zander

Loc: 6, on soil, epilithic, EMA 144, det. 02.06.2008 MKIR and EMA

Orthotrichaceae

Orthotrichum affine Schrad. ex Brid.

Loc: 10, epiphytic, EMA 288, det. 28.07.2008 MKIR and EMA

Orthotrichum cupulatum Hoffm. ex Brid.

Loc: 4, epilithic, epiphytic, EMA 39b, det. 19.03.2008 MKIR and EMA

Orthotrichum diaphanum Schrad. Ex Brid.

Loc: 2, 3, 5, 7, 8, 11, epiphytic, EMA 13, det. 20.11.2007 MKIR and EMA

Orthotrichum lyellii Hook. and Taylor

Loc: 5, epiphytic, EMA 84, det. 02.01.2008 MKIR and EMA

Orthotrichum pallens Bruch ex Brid.

Loc: 5,10, epiphytic, EMA 311, det. 01.08.2008 MKIR and EMA

Orthotrichum pumilum Sw. ex anon.

Loc: 7,11, epiphytic, EMA 176, det. 25.04.2008 MKIR and EMA

Orthotrichum rivulare Turner

Loc: 10, epiphytic, EMA 311, det. 01.08.2008 MKIR and EMA

Orthotrichum rupestre Schleich. ex Schwägr.

Loc: 4, epiphytic, EMA 39b, det. 19.03.2008 MKIR and EMA

Orthotrichum speciosum Nees

Loc: 11, epiphytic, EMA 323, det. 05.07.2008 MKIR and EMA

Bartramiaceae

Anacolia webbii (Mont.) Schimp.

Loc: 4, on soil, soil covered rock, EMA 35b, det. 06.02.2008 MKIR and EMA

Bartramia stricta Brid.

Loc: 3, 5, on soil, EMA 29, det. 05.02.2008 MKIR and EMA

BRYACEAE

Bryum archangelicum Bruch and Schimp.

Loc: 5, on soil, epilithic, EMA 104, det. 01.08.2008 MKIR and EMA

Bryum argenteum Hedw.

Loc: 1, 2, 3, 5, 11, 13, on soil, epilithic, EMA 73, det. 30.05.2008 MKIR and EMA

Bryum caespiticium Hedw.

Loc: 10, soil covered rock, EMA 278, det. 08.07.2008 MKIR and EMA

Bryum capillare Hedw.

Loc: 1, 3, 5, 6, 8, on soil, EMA 136, det. 13.03.2008 MKIR and EMA

Bryum dichotomum Hedw.

Loc: 3, 5, on soil, EMA 75, det. 30.05.2008 MKIR and EMA

Bryum gemmilucens R. Wilczek and Demaret

Loc: 10, on soil, EMA 284b, det. 08.08.2008 MKIR and EMA

Bryum pseudotriquetrum subsp. *bimum* (Schreb.) Lilj.

Loc: 5 on soil, EMA 60, det. 02.06.2008 MKIR and EMA

Bryum pseudotriquetrum (Hedw.) P.Gaertn. *et al.* var. *pseudotriquetrum*

Loc: 3, on soil, soil covered rock, EMA 199, det. 08.08.2008 MKIR and EMA

Bryum torquescens Bruch and Schimp.

Loc: 10, epiphytic, EMA 312, det. 08.08.2008 MKIR and EMA

Epipterygium tozeri (Grev.) Lindb.

Loc: 3, on soil, EMA 198b, det. 24.03.2008 MKIR and EMA

Pohlia wahlenbergii var. *calcareae* (Warnst.) E.F. Warb.

Loc: 10, epilithic, EMA 308, det. 30.07.2008 MKIR and EMA

Pohlia wahlenbergii var. *wahlenbergii* (F. Weber and D. Mohr) A.L. Andrews

Loc: 10, epilithic, EMA 309, det. 30.07.2008 MKIR and EMA

Brachytheciaceae

Isoetecium alopecuroides (Lam. ex Dubois) Isov.

Loc: 4, on soil, epilithic, ERD 2845a, det. 10.11.2001 ERD

Scorpiurium circinatum (Bruch.) M. Fleisch. and Loeske

Loc: 5, 9, epilithic, epiphytic, EMA 117, det. 02.08.2008 MKIR and EMA

Scorpiurium sendtneri (Schimp.) M. Fleisch.

Loc: 3, 5, 9, 10, epilithic, epiphytic, EMA 123, det. 01.08.2008 MKIR and EMA

Plasteurhynchium striatulum (Spruce) M.Fleisch.

Loc: 2, 5, on soil, EMA 15, det. 19.03.2008, MKIR and EMA

Platyhypnidium lusitanicum (Schimp.) Ochyra and Bednarek-Ochyra

Loc: 9, on soil, EMA 265, det. 07.08.2008 MKIR and EMA

Rhynchostegium megapolitanum (Blandow ex F. Weber and D. Mohr) Schimp.

Loc: 5, on soil, EMA 112b, det. 19.03.2008 MKIR and EMA

Rhynchostegium murale (Hedw.) Schimp.

Loc: 5, soil covered rock, EMA 113b, det. 19.03.2008 MKIR and EMA

Rhynchostegiella curviseta (Brid.) Limpr.

Loc: 3, epilithic, EMA 171a, det. 04.06.2008 MKIR and EMA

Rhynchostegiella tenella (Dicks.) Limpr.

Loc: 3, on soil, epilithic, EMA 171a, det. 04.06.2008 MKIR and EMA

Cirriophyllum crassinervium (Taylor) Loeske and M.Fleisch.

Loc: 5, epilithic, EMA 111, det. 02.08.2008 MKIR and EMA

Oxyeurhynchium hians (Hedw.) Loeske

Loc: 4, epilithic, EMA 36, det. 05.05.2008 MKIR and EMA

Oxyeurhynchium schleicheri (R. Hedw.) Röll

Loc: 3, epilithic, EMA 227, det. 05.05.2008,

Brachytheciastrum velutinum (Hedw.) Ignatov and Huttunen.

Loc: 5, on soil, EMA 126, det. 02.08.2008 MKIR and EMA

Brachythecium glareosum (Bruch ex Spruce) Schimp.

Loc: 6, on soil, EMA 159, det. 19.03.2008 MKIR and EMA

Scleropodium cespitans (Wilson ex Müll. Hal.) L.F. Koch

Loc: 5, on soil, EMA 58, det. 02.01.2008 MKIR and EMA

Scleropodium touretii (Brid.) L. F. Koch

Loc: 3, 5, on soil, EMA 60, det. 02.06.2008 MKIR and EMA

Homalothecium aureum (Spruce) H. Rob.

Loc: 3, on soil, EMA 28, det. 11.01.2008 MKIR and EMA

Homalothecium sericeum (Hedw.) Schimp.

Loc: 5, 9, epiphytic, EMA 244, det. 06.08.2008 MKIR and EMA

Fabroniaceae

Fabronia pusilla Raddi

Loc: 5, epiphytic, EMA 109, det. 11.03.2008 MKIR and EMA

Hypnaceae

Hypnum andoi A.J.E.Sm.

Loc: 9, epiphytic, EMA 246, det. 05.08.2008 MKIR and EMA

Hypnum cupressiforme Hedw.

Loc: 5, 10, on soil, EMA 81, 07.06.2008 MKIR and EMA

Hypnum juntilandicum Holmen and E. Warncke

Loc: 10, on soil, EMA 289, det. 28.07.2008 MKIR and EMA

Leucodontaceae

Leucodon sciuroides (Hedw.) Schwägr.

Loc: 5, epiphytic, EMA 114, det. 11.03.2008 MKIR and EMA

Pterogonium gracile (Hedw.) Sm.

Loc: 10, epiphytic, EMA 286, det. 28.07.2008 MKIR and EMA

DISCUSSION

Floristic remarks: The results indicated that Ricciaceae (6 taxa belong to one genera), Sphaerocarpaceae (3 taxa in 2 genera) and Codoniaceae (3 taxa in 2 genera) are the richest families among the hepatics in terms of species number. *Riccia* is the richest genus with most species (6 taxa). Pottiaceae (53 taxa belong to 16 genera), Brachytheciaceae (18 taxa belong to 11 genera), *Bryaceae* (12 taxa belong to 3 genera), Orthotrichaceae (9 taxa belong to one genera), Grimmiaceae (8 taxa belong to 2 genera) and Funariaceae (6 taxa belong to 2 genera) are the richest families in terms of the species they have and they constitute 86.1% of the flora (106 taxa). Acrocarpous (tuft-forming) species constitute 80.4% of the flora (99 taxa) as an expected result due to climatic conditions. Polytrichaceae is a monotypically represented family in the area.

Fossombronia echinata Macvicar from Çamlık/Aydin (Blockeel *et al.*, 2009) and *Crossidium crassinerve* (De Not.) Jur. from Aydin (Bozdoğan, Yamalak Town) and Denizli (Babadag) (Kirmaci *et al.*, 2009) included in Turkish bryoflora newly were collected from our study area for the second time. *Riccia* sp., *Petalophyllum ralfsii*, *Sphaerocarpos* sp., *Phascum* sp., *Acaulon muticum* and *Phaeoceros laevis* were the some annual and ephemeral bryophytes. These taxa appear seasonally under ideal growing conditions and are often overlooked. Although, *Microbryum* sp., *Fissidens* sp., *Bryum caespiticum*, *B. dunance*, *Pleurochaete squarrosa*, *Timmiaella barbuloides*, *Barbula ungiuculata*, *Enthostodon pulchellus* are prominent as colonizers of soil and soil banks, *Bryum argenteum*, *Orthotrichum cupulatum*, *O. rupestre*, *Didymodon vinealis* and *Grimmia lisae* are common taxa on limestone rocks. *Didymodon luridus*, *D. rigidulus*, *Pseudocrossidium revolutum*, *Aloina aloides* and *Grimmia pulvinata* can be found in both soil and rocks. *Fabronia pusilla*, *Orthotrichum speciosum*, *O. pumilum*, *O. diaphanum* and *O. affine* are the most common taxa as epiphytes. Nevertheless *Leucodon sciuroides*, *Pterogonium gracile* and *Homalothecium sericeum* can live both on rocks and tree trunks. Besides, some bryophytes were identified on different substratum (Table 1).

Table 1: Bryophytes were identified on different substratum

<i>Bryum dichotomum</i>	Baby shoe	On wool
<i>Didymodon acutus</i>	Slipper	
<i>Reboulia hemisphaerica</i>		On bone
<i>Fissidens bryoides</i>		
<i>Bryum</i> sp.		
<i>Oxyurhynchium hians</i>	On stiel	
<i>Bryum capillare</i>	Shoe	On plastic
<i>Didymodon acutus</i>	Shoe	On leather

Relationships between pollution and species: Air pollution plays a key role in changing the distribution of many plant species. Especially lower life forms as bryophytes and lichens are usually more affected by air pollution. Lack of significant cuticle or epidermis and leaves being only one cell thick make mosses and liverworts particularly well suited as bioindicators and biomonitors (Saxena and Harinder, 2004). Bryophytes mainly respond to air pollution by changes in their distribution and abundance (LeBlanc and DeSloover, 1970; Nash and Nash, 1974; Rao, 1982; Greven, 1992; Otnyukova, 1995). Comparing with Denizli and İzmir, Aydın is notably undeveloped in terms of industrialization. Soil industry, mining, heating systems and other small industry organizations are the main pollutants in the city. These use approximately 50 tons of unqualified coal and pollute the air. Furthermore, Aydın is one of the most crowded cities with recorded 215,639 motor vehicles. In addition, it is located on the İzmir-Denizli highway which has high traffic density. According to traffic administrative records, 24,000 motor vehicles use this road daily and consume approximately 4,500-5,000 liters fuel oil which releases 1,200 g lead to atmosphere. In spite of these pollutants, the pollution ratio in Aydın city centre didn't pass over the short term limited ratio for SO₂ (400 µg m⁻³) and particle substance (300 µg m⁻³) and also the long term limited ratio for SO₂ (150 µg m⁻³) and particle substance (150 µg m⁻³). Considering these data, it can be concluded that there is no air pollution in Aydın city centre (Aydın Province Environment Situation Report, 2006). Pollutants generally influence along with the İzmir-Denizli highway and in the centre of city more rather than other sites. *Tortula muralis*, *Grimmia pulvinata*, *Funaria hygrometrica*, *Bryum argenteum*, *Orthotrichum diaphanum* and *Didymodon vinealis* are common species found in the areas where urbanizations and traffic intensity are high. Most of these bryophytes are also common in European towns (Pokorny *et al.*, 2006). *Bryum argenteum*, *Grimmia pulvinata* and *T. muralis* were the most frequent in urban areas and were often the only species near busy main roads, which is an indication of their general tolerance to atmospheric pollution (Hill *et al.*, 1992). Another advantage of these species is to have high desiccation

tolerance. It is well known that water insufficiency is the other important problem in urban areas. Because of asphalt roads and pavements, rain water rapidly flows away. *Barbula unguiculata*, *Bryum capillare*, *Didymodon luridus*, *Didymodon rigidulus*, *Pseudocrossidium hornhuchianum*, *P. revolutum*, *Timmia barbuloidea*, *Pleurochaete suquarrosa* and *Bryum dichotomum* are localized in the protected areas of city centre such as gardens, cemeteries, school yards etc. These areas are necessary in order to protect of bryophytes. *Scorpiurium sentneri*, *Trichostomum crispulum*, *Fissidens bryoides*, *Bartramia stricta*, *Enthostodon pulchellus*, *Barbula convolute*, *Didymodon acutus* and *Dicranella varia* are bryophytes species found in villages belong to Aydın city centre. This classification may give some information about sensitive bryophytes. It is clear that the number of bryophyte species decreased depending on the decrease of natural areas and the boost in urbanization and industrial activities.

The present study focused on the bryophyte flora of Aydın urban area which is bryologically unknown. This is thought to be a valuable contribution for understanding bryophyte flora of Turkey. And also this study adds to our knowledge of distribution of urban bryophytes. Besides, these results should be considered on future research into urban bryophyte floras as the composition of the flora, an indicator species and effect of pollution on environment.

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